

REMARKS

Claims 1-40 remain in the application. Claims 2-12, 14-16, 18-28, and 30-32 are withdrawn from consideration.

Claims 2, 4, 9, 14-18, 20, 25, 30-32 are presently withdrawn from further consideration as being drawn to a non-elected species, as are Claims 3, 5-8, 10-12, 19, 21-24, and 26-28, which depend directly or indirectly upon withdrawn claims. Applicants understand that the withdrawn claims are subject to rejoinder should they each ultimately be found to properly depend from an allowable base claim.

The Examiner objects to Claims 35 and 39 on the basis that they contain a hyperphenated limitation that seems to be contradictory.

The phrase objected to is "highest occupied molecular orbital – lowest unoccupied molecular orbital states of said active molecule". This phrase relates to the HOMO-LUMO gap of a molecule, which is well known to those skilled in this art. Paragraph 0006 briefly describes this. The difference of the energies of the HOMO and LUMO is called the band gap. Analogous to inorganic semiconductors, the HOMO level is to organic semiconductors what the valence band is to inorganic semiconductors, and the same analogy exists between the LUMO level and the conduction band. The energy difference between the HOMO and LUMO levels is regarded as the band gap energy.

Thus, the objected-to phrase is a term of art. Applicants know of no other way to present this phrase. The Examiner is respectfully requested to provide alternative wording in the event that he still wishes to maintain the objection.

The Examiner states that "for examination purposes, claims 35 and 39 will be considered to be performance limitations that would naturally be met by the structure of the applied prior art that reads on the structure claimed by Applicant".

Applicants take issue with the statement that these "performance limitations" are met by the structure of the applied art, since the structure of the applied art utterly fails to read on Applicants' claimed structure, as argued in greater detail below. Indeed, these performance limitations serve to further distinguish Applicants' invention from the cited art. Specifically, Devonald teaches a self-assembly that orients NLO chromophores in the

direction of the field. The present invention presents a means to “space” switchable chromophores so the rotor elements can rotate freely. The teachings of Devonald et al do not disclose the operationally critical spacing requirement of the present switch chemistry. Whatever performance limitations the Examiner is referring to seem mute, since Devonald et al do not teach the element of spacing that enables the operation of the present rotor-stator switch.

Claims 1, 3, 5-8, 10-13, 17, 19, 21-24, and 26-29 are rejected under 35 USC 103(a) as being unpatentable over Devonald et al (U.S. Patent 5,275,924).

The comments made in Applicants’ previous Amendment obtain here as well.

In the present Office Action, the Examiner states in his rejection of Claims 1 and 17 that Devonald et al teach a multi-layer structure for optical switching including “a second monolayer of active molecules comprising a plurality of rotor moieties and stator moieties, with one rotor moiety supported between two stator moieties”. The Examiner references the structures given at the bottom of Col. 1 and top of Col. 2 of Devonald et al in support of this assertion. There is nothing in the referenced structures nor any aspect of the overall teachings of Devonald et al that suggests a rotor-stator structure or function. Indeed, there is nothing in the teachings or structures of Devonald et al that suggests, implies or is capable of an instance of a field induced component rotation for any purpose.

Devonald et al fail to disclose or suggest Applicants’ claimed rotor-stator structure or function. “To establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).” M.P.E.P. § 2143.03. Accord, M.P.E.P. § 706.02(j). For at least these reasons, the rejection based on Devonald et al should be reconsidered and withdrawn.

Instead of rotor-stator structures, the structures of Devonald et al include non-linear optic (NLO) chromophores attached to “amphiphilic compounds and oligomers and polymers” (Col. 1, lines 49-51) that self-align the NLO chromophores into parallel orientation during multi-layer Langmuir-Blodgett (LB) fabrication. The amphiphilic compounds, oligomers and polymers comprise polar segments (shown in Col. 1, lines 60-68

through Col. 2, lines 1-8) and hydrophobic segments (Col. 2, lines 13-52, 56-63) that self-align under influence of an external mechanical force in the aqueous LB solution, polar end-to-polar end, hydrophobic end-to-hydrophobic end, during film formation allowing the attached NLO chromophores to correspondingly assume parallel alignment. The NLO chromophore "comprises a conjugated system of π -bonds, substituted at one end by one or more π -electron acceptor groups and at or near the other by a π -electron donor group" (Col. 3, lines 17-20).

As is well known in the art, NLO chromophore materials gain their changeable optical properties by polarization of the chromophore π -electrons along the chromophore axis between the acceptor and donor groups. This is normally accomplished through exposure to intense laser light or an electric field. "The size of the change is related to the first molecular hyperpolarisability, β , of the chromophore through both the size of β and the degree of molecular ordering. The size of the molecular hyperpolarisability is determined by the structure of the molecule" (Col. 1, lines 13-17), **not** by a rotation of any molecular segment.

The degree of molecular ordering, the principle aim of Devonald et al, is determined by the degree in which the NLO chromophores are aligned in parallel. The teachings of Devonald et al and the NLO molecules used in their teachings are significantly different than the localization-delocalization of π -electrons via rotor group rotation taught by the Applicants. The π -electrons of Devonald et al's NLO materials are fully conjugated, fully delocalized in all operating states of the molecule. Polarization of NLO molecules creates a shift in the position of the fully delocalized π -electrons that modifies the refractive index property of the molecule. In the present invention, the chromophore molecule assumes two distinct states in which the π -electrons are first delocalized over the entire molecule and secondly localized to specific segments of the molecule via breakage of conjugation by the rotation of a rotor segment. The rotor, in this case, includes acceptor-donor groups that form an electric dipole through which the external electric field may be coupled to control rotor rotation. The aim of the present invention is to provide a means to self-align the dipoles of the rotors orthogonal to the external field.

As such, the principle axes of the present switchable molecules are not required to be parallel, as taught by Devonald et al. In addition, the present invention includes spacer ("stick") elements between layers of molecules to allow unhindered rotor rotation. Such spacing is not suggested or anticipated by Devonald since NLO chromophores do not have rotating elements.

As a second component of the Claims 1 and 17 rejection, the Examiner suggests that the "seed" molecule approach of the present invention is taught by Devonald et al. The concept of using seeds, of course, are not novel to either Devonald et al or the present inventors, as seeds are common to virtually all chemical materials crystallizations. However, to self-assemble a seed layer, and to use the seed layer to control molecular orientation in a thin film preparation via self assembly techniques is novel. There is nothing in the reference nor any aspect of the overall teachings of Devonald et al that suggests the "seed" molecule approach of the present invention. Indeed, there is nothing in the teachings or structures of Devonald et al that suggests, implies or is capable of an instance of the "seed" molecule approach for any purpose.

The Examiner rejects claims 13 and 29 on the grounds that Devonald et al teach a three-dimensional molecular assembly producing an optical device and that it would be obvious to include electrodes around such a molecular assembly. Indeed, there are many optical devices having three-dimensional molecular assembly that incorporate sandwiching electrodes. Examples include electrochromic filters and organic light emitting diodes. Each is individually patentable because the molecular assemblies are distinguishable in fundamental chemistry and function. As outlined above, the molecular assemblies of Devonald et al and the present invention are fully distinguishable in fundamental chemistry and function.

It appears that the Examiner equates X in the molecules listed at Col. 1, line 60 through Col. 1, line 10, with Applicants' claimed rotor. However, there is absolutely nothing in Devonald et al that suggests that the X moieties switch from one state to a different state by an applied electric field. While the Examiner argues that the electro-optic memory of Devonald et al comprises such disclosure, it is clear that the Examiner can only be relying on Applicants' own disclosure, using impermissible hindsight, to ar-

rive at such a conclusion. Applicants continue to request that the Examiner cite the column and line number that the X moieties of Devonald et al comprise rotors or otherwise withdraw the rejection.

Devonald et al disclose that “[n]on-centrosymmetric **films** ... are suitable for use in optical switching devices ...” (Col. 9, lines 53-54), but this fails to disclose or suggest Applicants’ **switch assembly** as claimed, with a monolayer of active molecules situated between spacer molecules, where the active molecules comprise a plurality of rotor moieties and stator moieties.

Devonald et al disclose that “[n]on-centrosymmetric **films** ... are suitable for use in optical switching devices ...” (Col. 9, lines 53-54), but this fails to disclose or suggest Applicants’ organized and controllable molecular self-assembly as claimed, with a monolayer of active molecules situated between spacer molecules, where the active molecules comprise a plurality of rotor moieties and stator moieties. In the application, Applicants also disclosed what kind of materials are suitable for their organized and controllable molecular self-assembly.

In the present application, the “*active molecules*” are designed in such a way that they have at least one *linker* unit attached directly onto certain stator portion of the molecule. In fact, the *linker* unit(s) belong(s) to part of the stator. Each *linker* in turn must have two or more functional groups, each pointing in different, preferably opposite, directions. All the functional groups in the *linker* can be identical or different. If they are different, one of the groups must have a much stronger affinity (than the other functional groups) to self-assemble with the “seeds” already bonded to the bottom substrate. This preferential linking ability will ensure that all the “*active molecules*” will line up in the same way. On the other hand, in the case of the functional groups in a *linker* being identical, only one of them will link with the “seeds”, due to steric effects. In general, the bonding between the functional groups that are linked together can be either physical or chemical.

Not all stators in the “*active molecules*” necessarily have a *linker* unit attached to them, as shown schematically in Figure 2A. When the linkers are not fully populated, the linkers can be attached onto the stators close to the edge of the molecules, or away

from the edge, depending on the application. Furthermore, the linker units should not have a significant impact on the overall chromophore or electronic properties of the active molecules.

A third critical component, the “*spacer*”, is required in order to join two adjacent layers of “*active molecules*” together in a very precise way through two separate self-assembly processes. Chemically, the “*spacer*” is some special-purpose molecules, ions or atoms that serve as a molecular “glue”. The challenge here, however, is to assemble them layer-by-layer without creating intermolecular interference, especially not to hinder the rotational movement of rotor in the “*active molecules*.” Another equally demanding challenge is that the layering structure must provide just enough - but not too much - room for the rotors to rotate. The reason it is desired to minimize the interlayer spacing is that the digital dye could operate with the least power consumption.

Through Applicants’ three-step controllable organized assembling process, the molecular orientation and the thin film thickness can be controlled precisely. The process uses a simple dipping or immersing method, involving no expensive, high-precision equipment. The entire process can be easily scaled up to industrial process, such as roll-to-roll for large-scale industrial production.

Please note that the *active molecules* in this invention are generally custom designed with certain sought-after characteristics, be it storage or display, whereas the *sticks* and *seeds* are generally off-the-shelf compounds or sometimes custom designed. The *active molecules* are so engineered that they would form certain linkage, preferably via ionic bonds or metal chelation, with certain functional groups in the *spacers* or *seeds*. As a requirement, the active molecules, spacers, or seeds in this organized assembly must be soluble in certain appropriate solvents or solvent mixtures so that the process of self-assembly can take place. But once self-assembled onto their counterparts, such molecules, however, will not back dissolve in the reagent solutions during the subsequent processing steps. This ensured the production of a high quality 3-D thin film by this controllable, organized assembly method.

Contrary to the Examiner’s assertions, it is clear that Devonald et al do not even remotely suggest all of the elements recited in Applicants’ claims.

The Devonald et al device effectively creates a continuously variable refractive index device, the variation being proportional to the incident photon electric field. A switch of this type requires that the change in refraction be of such a degree that light is deflected on or off an optical transmission axis. This is not an on-off switch of the type Applicants describe and claim.

Finally, the Examiner has failed to recognize the fundamental distinctions between the Langmuir-Blodgett film growth techniques of Devonald et al and Applicants' claimed molecular self-assembly growth. These distinctions were argued in Applicants' previous Amendment filed June 26, 2006, but the Examiner continues to ignore these distinctions. Molecular self-assembly is simply not LB growth. LB growth is external force-dependent molecular assembly, not self-assembly; see, e.g., paragraph 0013 of Applicants' specification, which requires the use of amphiphilic molecules having a hydrophilic end and a hydrophobic end, with an alkyl chain in the middle, to thereby form head-head (H-H) and tail-tail (T-T) orientations, as is also described by Devonald et al. Applicants' molecules are not so limited. LB growth simply fails to disclose or suggest molecular self-assembly, as it is understood by those skilled in this art.

Contrary to the Examiner's assertions, it is clear that Devonald et al do not even remotely suggest all of the elements recited in Applicants' claims.

Reconsideration of the rejection of 1, 3, 5-8, 10-13, 17, 19, 21-24, and 26-29 under 35 USC 103(a) as being unpatentable over Devonald et al is respectfully requested.

Claims 33-40 are rejected under 35 USC 103(a) as being unpatentable over Devonald et al in view of Vincent et al (U.S. Patent 6,556,470).

The Devonald et al reference is discussed above. Vincent et al, cited by Applicants in an Information Disclosure Statement filed on January 3, 2006, discloses field addressable rewritable media, employing an electrochromic molecular colorant.

The Examiner admits that Devonald et al do not explicitly disclose switching between a transparent state and a colored state. As an aside, it is reiterated that Devonald et al do not teach switching at all, let alone between a transparent state and a colored state. The Devonald et al device is analogous to a variable resistor (varying properties)

whereas Applicants' device is a true single-pole, single throw switch (a digital on-off device).

The Examiner uses Applicants' own disclosure taken with the teachings of Devonald et al to reject Claims 33-40. Here, the Examiner claims that the rotor-stator structure of Vincent et al could be self-assembled using the teachings of Devonald et al to produce field addressable rewritable memory and devices that switch from one color to another. The teachings of Devonald et al, however, do not include means to separate layers as necessary to allow free rotor rotation. Consequently, the rotor-stator structure of Vincent et al would be inoperable if assembled using the teachings of Devonald et al. Ignoring fundamental differences in the chemistry and function of the Devonald et al and the present invention, and further ignoring the process differences taught by each, the Devonald invention is directed towards a single active molecular layer in which NLO chromophores self-align in parallel orientation, with no provision for layer spacing since NLO chromophores are operable without component rotation or other movement.

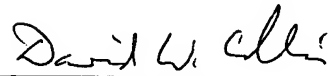
Reconsideration of the rejection of Claims 33-40 under 35 USC 103(a) as being unpatentable over Devonald et al in view of Vincent et al is respectfully requested.

The Examiner cites Zhang et al (U.S. Patent 6,751,365 B1) and Vincent et al (U.S. Patent 6,809,956) as being relevant to the present application. These references, cited by Applicants in a previously-submitted Information Disclosure Statement, are considered to be exemplary of rotor-stator configurations of molecules and of displays incorporating, e.g., molecules having rotor-stator configuration, respectively.

The application is considered to be in condition for allowance. The Examiner is respectfully requested to take such action. If the Examiner has any questions, he is invited to contact the undersigned at the below-listed telephone number. HOWEVER, ALL WRITTEN COMMUNICATIONS SHOULD CONTINUE TO BE DIRECTED TO: IP ADMINISTRATION, LEGAL DEPARTMENT, M/S 35, HEWLETT-PACKARD COMPANY, P.O. BOX 272400, FORT COLLINS, CO 80527-2400.

Respectfully submitted,

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